

DISTRIBUTION OF THE DIANA FRITILLARY, *SPEYERIA DIANA* (NYMPHALIDAE) IN ARKANSAS, WITH NOTES ON NECTAR PLANT AND HABITAT PREFERENCE

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ABSTRACT. Investigation of the distribution, preferred nectar plants, and habitat associations of Diana Fritillary, *Speyeria diana*, Cramer in Arkansas was undertaken. Arkansas populations form a disjunct group separate from larger populations of this species in the Appalachian Mountains. Researchers have suggested that *S. diana* has declined over much of its range, including the Ozark and Ouachita Mountains of Arkansas, so that only a few populations are currently known in this area. Previous surveys found this butterfly in only nine Arkansas counties. We observed populations of this butterfly in 14 counties, 11 which were new county records. In addition, we confirmed populations in two counties where the butterfly had not been recorded in over 20 years. Observations made during this study combined with previous survey work indicate that this species is distributed throughout the Ozark and Ouachita mountains in Arkansas, occupying 22 counties. Individuals were found to occupy two types of habitat; prairie and wetland, which appeared to contain specific nectar plants that *S. diana* prefers. We suggest that the loss of these habitats and associated nectar plants has been the primary cause of the butterfly's decline, but with proper management and protection of these habitats, the species may be increasing. Therefore, *S. diana* does not appear to be in immediate risk of extirpation in Arkansas although monitoring of existing populations is warranted.

Additional key words: survey, Ozark Mountain, Ouachita Mountain, prairie, wetlands, habitat loss.

Several North American fritillary butterflies have become endangered in the last century, often because of habitat alteration (Hammond & McCorkle 1983, Hammond 1995). One species of concern has been the Diana Fritillary, *Speyeria diana* Cramer (Nymphalidae). The historical range of *S. diana* extended from the Chesapeake Bay region, across the southern Appalachians, through Tennessee, Kentucky, and into northern Georgia, Alabama, and Mississippi. Possible disjunct populations existed in Arkansas and southern Missouri, ending at the deciduous forest/prairie ecotone in eastern Oklahoma and Kansas (Hovanitz 1963, Carlton & Nobles 1996). Several authors have suggested a great decline throughout much of the range of *S. diana* (Clark 1951, Shull 1987, Howe 1975) so that currently, populations exist only in the Appalachian Mountains and the Interior Highlands of the Ozark Plateau and Ouachita Mountains covering Arkansas, Missouri, and Oklahoma (Carlton & Nobles 1996). Survey work conducted by Carlton and Nobles in 1996 found *S. diana* at several Ozark and Ouachita localities covering nine counties. The authors suggested that the populations were small and isolated and therefore at high risk for extinction.

Speyeria diana emerges in late spring, mating occurs in early summer, after which males disappear and presumably die. Females are seldom seen during the rest of the summer months, but become active again in mid-autumn to oviposit. Eggs are deposited on the ground, the larvae hatch and overwinter as first stadium larvae. In early Spring, the larvae become active again, feed on various species of violet (*Viola* spp. L.), and pupate by mid-spring. There is one generation per year (Howe 1975).

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To document further the range of *S. diana* in the western portion of its range, we conducted surveys throughout Arkansas, focusing on areas where the butterflies were not observed in the Carlton and Nobles (1996) survey. We also searched areas that had historical records that have not been confirmed in recent years. Observations on the behavior of each butterfly observed were made, primarily nectar plant preferences to determine possible habitat requirements.

MATERIALS AND METHODS

During the summers of 1997–1999 we performed extensive surveys of Arkansas habitats for *S. diana*. A total of 23 counties were surveyed by the authors near the known range of the butterfly. Additional records were provided by The Nature Conservancy, the National Forest Service, and other scientists in Arkansas. For each butterfly observed, we recorded its sex, noted its behavior when sighted, and the associated habitat. All observations were performed during June, July, and early August when adult butterflies are active. We began by focussing on areas with known (although old) records of *S. diana*, and then surveyed surrounding counties that did not have published records of this species.

Surveys were performed on public lands by walking trails and driving back roads. In particular, areas that contained significant concentrations of nectar plants were searched carefully for *S. diana*. In areas of private land, we drove slowly along roadsides searching for possible nectar plants. We searched a variety of available habitats including mature forest, wetlands, prairies, and human-disturbed areas. A total of 375 man-hours were spent searching in the field.

RESULTS

Individuals of *Speyeria diana* were observed each year of the study (1997–1999) at numerous sites across Arkansas. Records from observers other than the authors were also added in 2000–2001. Butterflies were found in 14 different Arkansas counties, 11 of which represent new county records. Two of these counties, Conway and Faulkner, have not had sightings of this species in over 20 years. Below are the initial observations from each county (i.e., first time we observed specimens). Observations were made by the authors unless otherwise indicated.

Conway Co.; Petit Jean St. Park, West end of Bailey Lake, 10 July 1998, one female nectaring on buttonbush (*Cephalanthus occidentalis* L.); **Faulkner Co.;** Camp Robinson National Guard Base, along Cemetery Road, forested wetland, 7 July 1997, four males and one female nectaring on *C. occidentalis*; **Pulaski Co.;** Camp Robinson National Guard Base, along Clinton Rd., south of Clifton Mountain, forested wetland, 7 July 1997, one male nectaring on *C. occidentalis*; **Yell Co.;** Mt. Nebo St. Park, Fern Lake near Summit Park Trail, 10 July 1998, one male nectaring on *C. occidentalis*; **Johnson Co.;** Ozark Highlands Trail in Hurricane Creek Wilderness, open glade, 17 July 1997, one male nectaring on Purple Coneflower (*Echinacea purpurea* Moench), P. Kilgore; **Logan Co.;** Mt Magazine, one-half kilometer west of Signal Hill summit, open glade, 25 June 1997, 5 males and 1 female nectaring on *E. purpurea*, MDM and P. Kilgore; **Howard Co.;** Stone Road Glade Natural Area, June 1998, 3 males nectaring on Pale Purple Coneflower (*Echinacea pallida* Britton) and 1 female nectaring on Compass Plant (*Silphium laciniatum* L.), Douglas Zollner; **Hempstead Co.;** Grandview Prairie Wildlife Management Area, numerous males and females sighted during summer of 1998 and 1999, Douglas Zollner; **Clark Co.;** Terre Noire Natural Area, June 1997, 1 male nectaring on *E. pallida*, and July 1999, 3 females nectaring on *S. laciniatum*, Douglas Zollner; **Jefferson Co.;** Pine Bluff Arenal, June 1999, 2 males and 1 female nectaring on *E. pallida*, Douglas Zollner; **Saline Co.;** Dry Lost Creek Preserve, late May 1999, 3 males nectaring on Arkansas calamint (*Satureia arkansana* Nutt.), and June 1999, 1 female nectaring on slender mountain mint (*Pycnanthemum albescens* Torr.), Douglas Zollner; **Polk Co.;** Ouachita National Forest, Forest Service Rd 1401, about 10 miles south of Mena, AR, 1 July 2000, 1 female, Craig Rudolph; **Garland Co.;** Ouachita National Forest, Mazarn Creek and Forest Service Rd. 829, 2 June 2000, 2 males, Craig Rudolph; **Pike Co.;** Ouachita Na-

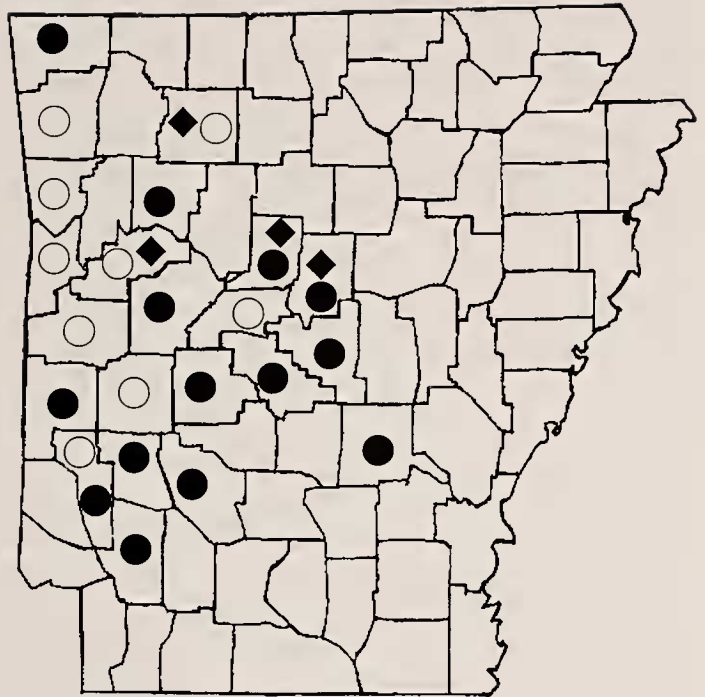


FIG. 1. Range map of the Diana Fritillary (*Speyeria diana*) in Arkansas based on surveys from this study and previous records. Diamonds = old observations from published literature; open circles = Carlton and Nobles (1996) observations, Closed circles = observations from this study.

tional Forest, Highway 84, 4.2 miles west of Salem, AR, 7 June 2001, 1 male, Craig Rudolph; **Benton Co.;** Wedington Natural Area, 24 July 2002, 1 male, Lori Spencer. These records indicate populations exist throughout much of the western one-half of Arkansas, primarily in the mountainous and foothill regions of the state. (Fig. 1). Our surveys in the eastern portion of the state failed to record any individuals except for the Jefferson County record provided by the Nature Conservancy.

Populations of *S. diana* were found in two types of habitats, prairie and wetland. In southwest Arkansas, many butterflies were found in prairie habitat. Individuals in four sites (Stone Road Glade, Grandview Prairie, Terre Noire, and Dry Lost Creek) were found in the year after prescribed burns. In the Ozark and Ouachita mountains, *S. diana* was associated with small natural prairie openings (e.g., Magazine Mountain, Hurricane Creek Wilderness) while those in central Arkansas were found in wetland areas (e.g., swamps in Camp Robinson, Mt. Nebo, and along Baily Lake).

During our field observations we also recorded the activity of the butterflies. The vast majority of individuals were nectaring, however, butterflies were often observed on only a few species, with Buttonbush (*C. occidentalis*) and coneflowers (*Echinacea* spp.) the most commonly utilized plants (Table 1). Females

TABLE 1. Percentage of individual male and female *S. diana* observed on various nectar plants. N = number of individuals observed.

Nectar Plant	Percent Males (N = 46)	Percent Females (N = 23)
<i>Cephalanthus occidentalis</i>	56.5	26.1
<i>Echinacea purpurea</i>	21.7	8.1
<i>Echinacea pallida</i>	13.0	21.7
<i>Pycnanthemum albescens</i>	6.5	4.3
<i>Rubus</i> sp.	2.2	0.0
<i>Silphium laciniatum</i>	0.0	34.8
<i>Satureja arkansana</i>	0.0	4.3

were frequently observed on Compass Plant (*S. laciniatum*) on prairie sites. Several other plant species were present at our sites and used by other species of butterfly. Although there were more males than females observed, this may not indicate an actual biased sex ratio as males have bright coloration and are therefore easier to detect in the field. The habitat preference (wetland or prairie) seemed to be determined by the presence of preferred nectar plants, and not the habitat per se.

DISCUSSION

Our results indicate that the Diana Fritillary is more widespread than previously thought. Based on our newly constructed range map (Fig. 1) and habitat observations, *S. diana* appears to range throughout the Ouachita and Ozark Mountains of Arkansas, where there is suitable wetland and/or prairie habitat with preferred nectar plants. We also performed extensive surveys throughout eastern Arkansas, but were unable to locate any individuals, even though preferred nectar plants utilized in other areas were present.

It has been suggested that clearing of old-growth forest in the eastern United States has been primarily responsible for the decline of *S. diana*, due to larval host plant decline (Clark 1951, Howe 1975, Hammond & McCorkle 1983, Shull 1987). However, based on our observations, we find this explanation wanting. *Speyeria diana* larvae feed on several species of violets (*Viola* spp.), which are extremely common in Arkansas. Many of our observations and observations by Carlton and Nobles (1996) were in at least moderately disturbed habitat. The largest number of sightings in this study were in the Camp Robinson National Guard Base and surrounding areas, habitat that is mostly second growth forest and pasture, and is frequently burned due to military firing exercises. Butterflies were also observed after prescribed burning at several sites, further indicating that this type of disturbance is not the primary cause of the butterfly's decline. Reports from the National Forest Service sites

in western Arkansas indicate that butterflies become more common after prescribed burns are undertaken for Red Cockaded Woodpecker habitat (C. Rudolph, pers. com.). We believe it is more likely that loss of wetland and prairie habitat and the associated loss of preferred nectar plants is the reason for this butterfly's decline. Throughout the United States, large areas of wetland have been drained (Weller 1981, Tiner 1984) and most prairie habitat has been lost to farmland conversion or has undergone succession to forest because of fire suppression (Humphrey & Mehrhoff 1958, Bock & Bock 1995).

It should be noted that we did not search for larvae, which may prefer quite different habitats compared to adults. The larval host plants (*Viola* spp.) are most common in moist forest. In addition, many butterflies (especially females) appear to prefer deep, shady forests during times of strong sunlight (P. C. Hammond, pers. com.). Therefore, high quality forest in the vicinity of quality nectar plants (i.e., mixture of forested and open habitats) may be important for this species.

The Diana Fritillary has an unusually long adult life span, especially females, which are observed from June to October (up to 5 months). Many long-lived butterflies require high quality nectar sources (e.g., *Heliconius*, Gilbert 1972), and we suggest this is the case for *S. diana*. The loss of prairie and wetland habitats, and subsequent loss of nectar plants may have contributed to the decline of this species throughout much of its range.

While our survey indicates *S. diana* is more widespread than previously thought, it is still a relatively rare butterfly. There are now 22 known populations in Arkansas, most of which are on public land. We suspect that further survey work will discover additional populations. It is unclear if the species' population is increasing or has simply been overlooked in the past. The latter may be the case, as males resemble the Great Spangled Fritillary, *Speyeria cybele* Fabricius and females are rather secretive and resemble several other species, especially the Red-Spotted Purple, *Basilarchia astyanax* Drury. It is also possible that changes in habitat management are benefiting this species, as prescribed burning has become more common and wetlands are better protected. While *S. diana* does not appear in immediate danger of extinction in the Ozark and Ouachita areas, future monitoring efforts will be required to determine if existing populations are stable.

ACKNOWLEDGMENTS

Douglas Zollner (The Nature Conservancy), Craig Rudolph (U.S. Forest Service), and Lori Spencer provided some of the county

records for this study. Parker Kilgore and Laura Skelton enthusiastically helped in field surveys. L. Spencer provided valuable criticisms to an earlier version of this manuscript. Paul C. Hammond and Jim Dunford provided helpful reviews.

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